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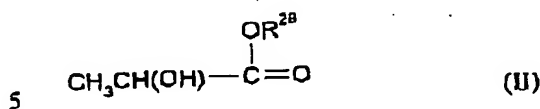
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CLAIMS

1. A process for the production of a lactate ester or acid of formula II



comprising the steps of carbonylating vinyl acetate with carbon monoxide in the presence of a source of hydroxyl groups and of a catalyst system, the catalyst system obtainable by combining:

- 10 (a) a metal of Group VIII B or a compound thereof; and  
(b) a bidentate phosphine of general formula (I) in accordance with the first aspect as defined herein

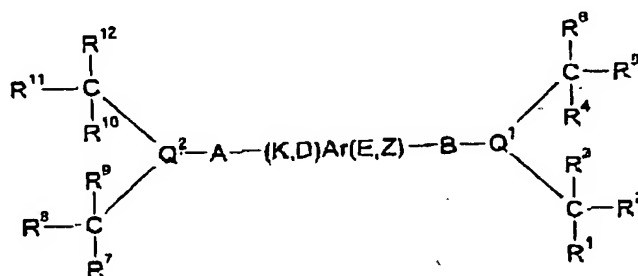
- 15 to produce a product comprising a branched (iso) product 2-acetoxy ( $\text{CH}_3$ ),  $\text{CH}_3\text{C}(\text{O})\text{OR}^{2a}$  wherein  $\text{R}^{2a}$  is selected from H, or a  $\text{C}_1$ - $\text{C}_{30}$  alkyl or aryl moiety which may be substituted or unsubstituted and either branched or linear and chemically treating the said branched (iso) product to produce the corresponding lactate or acid of formula II.

- 20 2. A process according to any preceding claim, wherein the ratio of branched :linear product from the carbonylation process is greater than 1.5:1.

3. A process for the carbonylation of vinyl acetate comprising reacting vinyl acetate with carbon monoxide in the presence of a source of hydroxyl groups and of a catalyst system, the catalyst system obtainable by combining:

- 25 (a) a metal of Group VIII B or a compound thereof; and  
(b) a bidentate phosphine of general formula (I)

30 (I)



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wherein:

Ar is a bridging group comprising an optionally substituted aryl moiety to which the phosphorus atoms are linked on available adjacent carbon atoms;

5 A and B each independently represent lower alkylene;

K, D, E and Z are substituents of the aryl moiety (Ar) and each independently represent hydrogen, lower alkyl, aryl, Het, halo, cyano, nitro,  $OR^{19}$ ,  $OC(O)R^{20}$ ,  $C(O)R^{21}$ ,  $C(O)OR^{22}$ ,  $NR^{23}R^{24}$ ,  $C(O)NR^{25}R^{26}$ ,  $C(S)R^{25}R^{26}$ ,  $SR^{27}$ ,  $C(O)SR^{27}$ , or  $-J-Q^3(CR^{13}(R^{14})(R^{15}))CR^{16}(R^{17})(R^{18})$

10 where J represents lower alkylene; or two adjacent groups selected from K, Z, D and E together with the carbon atoms of the aryl ring to which they are attached form a further phenyl ring, which is optionally substituted by one or more substituents selected from hydrogen, lower alkyl, halo, cyano, nitro,  $OR^{19}$ ,  $OC(O)R^{20}$ ,  $C(O)R^{21}$ ,  $C(O)OR^{22}$ ,  $NR^{23}R^{24}$ ,  $C(O)NR^{25}R^{26}$ ,  $C(S)R^{25}R^{26}$ ,  $SR^{27}$  or  $C(O)SR^{27}$  or, when Ar is a cyclopentadienyl group, Z may  
15 be represented by  $-M(L_1)_n(L_2)_m$  and Z is connected via a metal ligand bond to the cyclopentadienyl group;

$R^1$  to  $R^{18}$  each independently represent lower alkyl, aryl, or Het;

20  $R^{19}$  to  $R^{27}$  each independently represent hydrogen, lower alkyl, aryl or Het;

M represents a Group VIB or VIIB metal or metal cation thereof;

$L_1$  represents a cyclopentadienyl, indenyl or aryl group each of which groups are optionally  
25 substituted by one or more substituents selected from hydrogen, lower alkyl, halo, cyano, nitro,  $OR^{19}$ ,  $OC(O)R^{20}$ ,  $C(O)R^{21}$ ,  $C(O)OR^{22}$ ,  $NR^{23}R^{24}$ ,  $C(O)NR^{25}R^{26}$ ,  $C(S)R^{25}R^{26}$ ,  $SR^{27}$ ,  $C(O)SR^{27}$  or ferrocenyl;

$L_2$  represents one or more ligands each of which are independently selected from hydrogen,  
30 lower alkyl, alkylaryl, halo, CO,  $PR^{43}R^{44}R^{45}$  or  $NR^{46}R^{47}R^{48}$ ;

$R^{43}$  to  $R^{48}$  each independently represent hydrogen, lower alkyl, aryl or Het;

n = 0 or 1;

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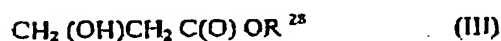
and  $m = 0$  to 5;

provided that when  $n = 1$  then  $m$  equals 0, and when  $n$  equals 0 then  $m$  does not equal 0;

- 5 Q<sup>1</sup>, Q<sup>2</sup> and Q<sup>3</sup> (when present) each independently represent phosphorous, arsenic or antimony and in the latter two cases references to phosphine or phosphorous above are amended accordingly.

4. A process for the production of 3-hydroxy propanoate ester or acid of formula (III)

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comprising the steps of:

carbonylating vinyl acetate with carbon monoxide in the presence of a source of hydroxyl

- 15 groups and of a catalyst system, the catalyst system obtainable by combining:

- (a) a metal of Group VIII B or a compound thereof; and
- (b) a bidentate phosphine of general formula (I) in accordance with either claim 1 or claim 2 as defined above

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wherein R<sup>28</sup> is selected from H, or a C<sub>1</sub>-C<sub>30</sub> alkyl or aryl moiety which may be substituted or unsubstituted and either branched or linear and carrying out a treatment step on the said linear (n) product 1-acetoxy CH<sub>2</sub>.CH<sub>2</sub>C(O)OR<sup>28</sup> to produce the 3-hydroxy propanoate ester or acid of formula (III).

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5. A process according to any preceding claim, wherein the Group VIII B metal is palladium.

6. A process according to any preceding claim, wherein the linear (n) and branched (iso) products of the carbonylation may be separated either before or after the treatment step.

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7. A process according to any preceding claim, wherein the products of the reaction are separated by distillation.

8. A process according to any preceding claim, wherein when K, D, E or Z represent -J-

- 35 Q<sup>1</sup>(CR<sup>13</sup>(R<sup>14</sup>)(R<sup>15</sup>))CR<sup>16</sup>(R<sup>17</sup>)(R<sup>18</sup>), the respective K, D, E or Z is on the aryl carbon adjacent

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the aryl carbon to which A or B is connected or, if not so adjacent, is adjacent a remaining K, D, E or Z group which itself represents  $-J-Q^3(CR^{13}(R^{14})(R^{15}))CR^{16}(R^{17})(R^{18})$ .

5 9. A process according to any preceding claim, wherein the process is used to catalyse the carbonylation of a vinyl acetate compound in the presence of carbon monoxide and a hydroxyl group containing compound.

10 10. A process according to any preceding claim, wherein the carbon monoxide may be used in pure form or diluted with an inert gas such as nitrogen, carbon dioxide or a noble gas such as argon.

11. A process according to any preceding claim, wherein the ratio (volume/volume) of vinyl acetate compound to hydroxyl group containing compound lies in the range of 1:0.1 to 1:10.

15 12. A process according to any preceding claim, wherein the amount of Group VIII metal is in the range  $10^{-7}$  to  $10^{-1}$  moles per mole of vinyl acetate compound.

20 13. A process according to any preceding claim, wherein the carbonylation of a vinyl acetate compound is performed in one or more aprotic solvents.

14. A process according to claim 13, wherein the aprotic solvent has a dielectric constant that is below 50 at 298.15 K and at  $1 \times 10^5 \text{ Nm}^{-2}$ .

25 15. A process according to any preceding claim, wherein the catalyst compounds act as a heterogeneous catalyst.

16. A process according to any of claims 1 to 14, wherein the catalyst compounds act as a homogeneous catalyst.

30 17. A process according to claim 15 wherein the process is carried out with the catalyst comprising a support.

18. A process according to claim 17, wherein the support is insoluble.

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19. A process according to either claim 17 or claim 18, wherein the support comprises a polymer such as a polyolefin, polystyrene or polystyrene copolymer such as a divinylbenzene copolymer or other suitable polymers or copolymers known to those skilled in the art; a silicon derivative such as a functionalised silica, a silicone or a silicone rubber; or other porous particulate material such as for example inorganic oxides and inorganic chlorides.

20. A process according to any preceding claim, wherein the carbonylation is carried out at a temperature of between  $-10$  to  $150^{\circ}\text{C}$ .

21. A process according to any preceding claim, wherein the carbonylation is carried out at a CO partial pressure of between  $0.80 \times 10^5 \text{ N.m}^{-2}$  to  $90 \times 10^5 \text{ N.m}^{-2}$ .

22. A process according to any of claims 1 to 20, wherein the carbonylation is carried out at a low CO partial pressure of between  $0.1$  to  $5 \times 10^5 \text{ N.m}^{-2}$ .

15

23. A process according to any preceding claim, wherein the bidentate phosphine is independently selected from any of the following: bis (di-*t*-butyl phosphino)-*o*-xylene (also known as 1,2 bis (di-*t*-butylphosphinomethyl) benzene); 1,2 bis (diadamantylphosphinomethyl) benzene; 1,2 bis (diadamantylphosphinomethyl) naphthalene; 1,2 bis (di-*t*-pentyl phosphino)-*o*-xylene (also known as 1,2 bis (di-*t*-pentyl-phosphinomethyl) benzene); bis 2,3 (di-*t*-butyl phosphinomethyl) naphthalene; 1,2-bis-(di-*t*-butylphosphinomethyl) ferrocene; 1,2,3-tris-(di-*t*-butylphosphinomethyl) ferrocene; 1,2 bis (diadamantylphosphinomethyl) ferrocene; and 1,2 bis (di-*t*-pentyl phosphinomethyl) ferrocene.

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24. The use of the catalyst system according to any preceding claim for the production of a lactate ester or acid of formula (II) the said production comprising the steps of carbonylation of a vinyl acetate followed by treatment of the branched (iso) product of the carbonylation to produce the ester or acid.

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25. The use of the catalyst system as defined in any of claims 1 to 23 for the production of a 3-hydroxy propanoate ester of formula (III) the said production comprising the steps of carbonylation of a vinyl acetate followed by treatment of the linear (n) product of the carbonylation.

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26. The use of a catalyst system as defined in any of claims 1 to 23, wherein the catalyst is attached to a support.

5 27. The use of a catalyst according to either claim 24 or claim 25, wherein the treatment is hydrolysis or transesterification.

28. The use of the catalyst according to claim 27, wherein the product is hydrogenated subsequent to hydrolysis.

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